OPERATION AND MAINTENANCE MANUAL

DIGISEC®
RI __/35C SERIES ENCODERS

MANUAL NO. 2781, REVISION H

NOVEMBER 1980

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*Incandescent Bulb Illumination

PREFACE

This Manual covers the entire family of DIGISEC® RI__/35C incremental encoders. Two basic types of encoders are covered. One type, which is no longer manufactured except for replacement purposes, utilizes incandescent bulbs as the source of illumination. A second type, in manufacture since July 1974, utilizes light emitting diodes (LED) as the source of illumination. The external details of the encoders are identical. The newer encoders using light emitting diodes have a much longer life.

An additional feature of the newer models is that some may be obtained with +5V power supply ratings, thus making them more compatible with modern TTL circuitry and systems.[1/] It is possible to obtain light emitting diode units which are wired to operate on +6V as direct replacements for some models of the older incandescent illumination encoders. In this type of installation, the -6V power supply lead to the encoder will "dead end" at the mating connector of the encoder and will not be utilized within the encoder. Owing to the large number of models tabulated and the possibility of damaging an encoder by applying the wrong voltage, please read this Manual thoroughly and identify the model before applying power. As a double check, power requirements are listed on the nameplate and should be verified at time of installation.

1/ See Table 1-2, Page 5

1. INTRODUCTION

1.1 SCOPE

This manual is to be used with the DIGISEC RI__/35C series of incremental shaft position encoders. The manual covers installation, operation, theory of operation, and field maintenance. The discussion has general application inasmuch as design, operation, and maintenance features are similar for all encoders in this series. Refer to Section 5 for identifying nomenclature applicable to all models in this series. Differences in models are also tabulated in Section 5, where encoders are grouped in "standard" and "nonstandard" groups. The standard group represents an off the shelf line of encoders with standardized outline dimensions, power supply requirements, and electrical connectors.

Maintenance or repair beyond that covered in this manual must be performed by the manufacturer.

1.2 GENERAL DESCRIPTION

Encoders of the DIGISEC RI__/35C series are medium resolution incremental shaft position encoders of the photoelectric, noncontacting type. These encoders are widely used in precision position, velocity, or acceleration sensing applications, such as navigation systems, gyro rate tables, ball trackers, and machine tool position and readout systems.

The general configuration of RI__/35C series encoders is that of 3.5 inch diameter cylindrical modules, as shown in Fig. 1-1. In operation, the encoder is synchro-mounted to a suitably aligned surface and coupled to the rotating shaft being monitored through a high accuracy flexible coupling. Except for external power supplies (+6 and -6 volts on standard models),[2/] the encoder is functionally self-contained. A shaft-mounted glass code disk, illuminating lamps or LED's, silicon photodetectors, and signal processing solid state circuits, which provide a sequence of output pulses as the encoder shaft is rotated, are contained within the cylindrical case of the encoder. The interpulse angular increment is determined by the encoder resolution, and the pulse characteristics depend on the encoder output option (paragraph 1.3). When the pulse information is applied to suitable counting logic, shaft position, speed, and acceleration are readily determined.

1.3 SPECIFICATIONS

Electrical, mechanical, and environmental specifications for the DIGISEC RI__/35C series are given in Table 1-1 and in Section 5.[1/] Fig. 1-2 shows the output waveforms provided for the four output options (Q,QZ,P, and PZ). Outputs A and B, available in all four options, are called quadrature outputs (or quadrature square waves) because the B square wave leads the A square wave by 1/4 cycle when the shaft is rotated in the clockwise direction, as viewed from the shaft end of the encoder. The two quadrature square waves are used as test points in the P and PZ options. The rated angular resolution of all RI_/35C encoders is equal to 1/4 square-wave cycle. Thus, an RI 15/35C encoder has 2^{15} quarter-cycles (2^{13} full cycles) of A or B square waves per revolution.

1/ Units shipped after 1/1/71 are labeled Q,QZ,QP, and QPZ. P and QP, and PZ and QPZ units are identical, and the old and new option designators are used interchangeably.

2/ +5V available on GaAs models.

The clockwise and counterclockwise outputs are available only in the P and PZ options. The pulse train at the clockwise output exists only when the encoder shaft is rotated clockwise. Similarly, the pulse train at the counterclockwise output exists only for counterclockwise rotation. These pulses coincide with the leading and lagging edges of both quadrature square waves and are therefore 1/4 square-wave cycle apart. Thus an RI15/35CP encoder provides 2^{15} clockwise or counterclockwise pulses per revolution.

Two zero index pulse output options are available, QZ and PZ. The QZ index pulse occurs once per revolution of the encoder shaft. Its leading and trailing edges coincide with successive square-wave edges of the A and B outputs (see Fig. 1-2). The PZ index pulse appears once per revolution of the encoder shaft in exact coincidence with one of the bidirectional (clockwise or counterclockwise) pulses. The angular location of the index pulse for the clockwise direction of rotation is separated from the counterclockwise location by one quantum width (1/4 square-wave cycle), as shown in Fig. 1-2.

1.4 DESIGN FEATURES

The DIGISEC RI__/35C series has been designed to meet the requirements of military and industrial applications with emphasis on reliability. All electronic circuits are solid state, with small size, long life, and high reliability. Output stages on standard models drive DTL/TTL with 10 unit load fanout capability.

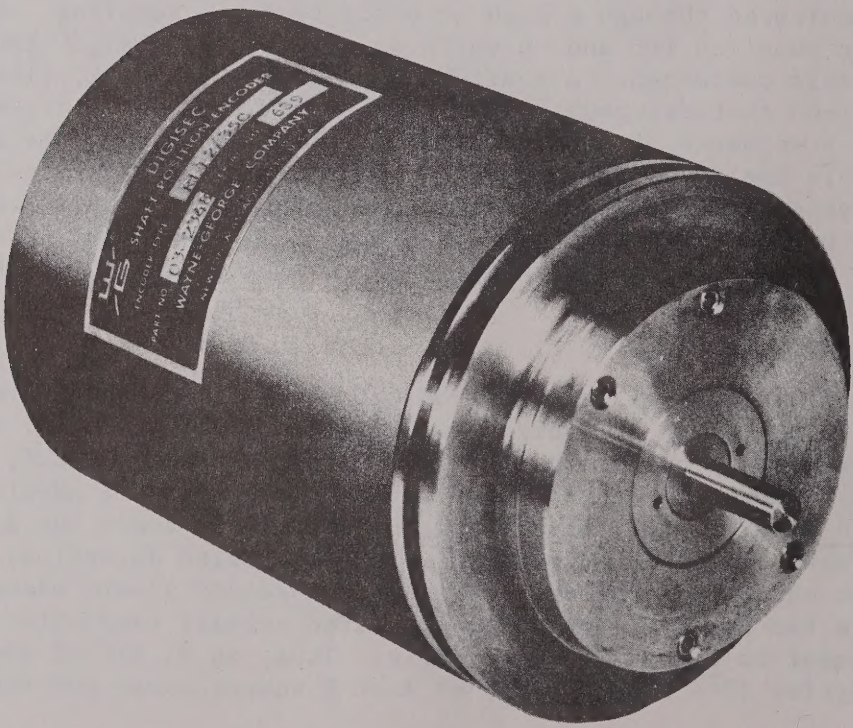


Fig. 1-1 — Typical DIGISEC RI__/35C series encoder

Table 1-1 Specifications for Standard DIGISEC RI__/35C Series Encoders*

Electrical

Output options		Q,QZ,QP,PZ (refer to Fig. 1-2 for output waveforms)
Resolution		Refer to Section 5
Accuracy, including quantization		± 1 count
A, B, and QZ index outputs		
Level		Logic "0" - 0 to +0.5V Logic "1" - +VDC, +0,-0.5V 1/
Output I.C.		932 DTL, Incandescent bulb models DM7095 TTL, GaAs LED models
Output Drive		10 TTL/ DTL unit loads (all models)
Clockwise, counterclockwise, and index pulse outputs		
Level		Logic "0" - 0.0 to 0.5V (no pulse) Logic "1" - +VDC, +0,-0.5V (pulse) 1/
Pulse width		2.0 ± 0.5 microsecond
Output I.C.		Same as A, B, QZ outputs
Output drive		Same as A, B, QZ outputs
Hysteresis		1 arc-second minimum
Power requirements (Incandescent bulb and GaAs LED X8,X16)	Voltage	+VDC,-6VDC ± 2 percent regulation, 1 percent maximum peak to peak ripple (see model table Section 5 for VDC)
	Current	See Table 1-2, Page 5
Power requirements (GaAs LED X4 only)	Voltage	+5V 2/, ± 2 percent regulation, 1 percent maximum peak to peak ripple
	Current	See Table 1-2, Page 5
Electrical connector		Cannon DA15P with mating connector supplied, pigtail optional

Mechanical

Weight	5.0 pounds maximum
Rotor moment of inertia	1.2 ounce-inches^2 maximum
Breakaway torque	0.5 ounce-inch maximum
Shaft loading	
Axial	5.0 pounds maximum
Radial	2.0 pounds maximum at .5 inch from mounting face
Slew speed	1,000 rpm maximum
Operating speed	Refer to Section 5
Dimensions	Refer to Section 5

Note: All RI __/35C series encoders are 3.5 inches in diameter

Temperature

Operating	-40 to +71°C
Storage	-62 to +85°C

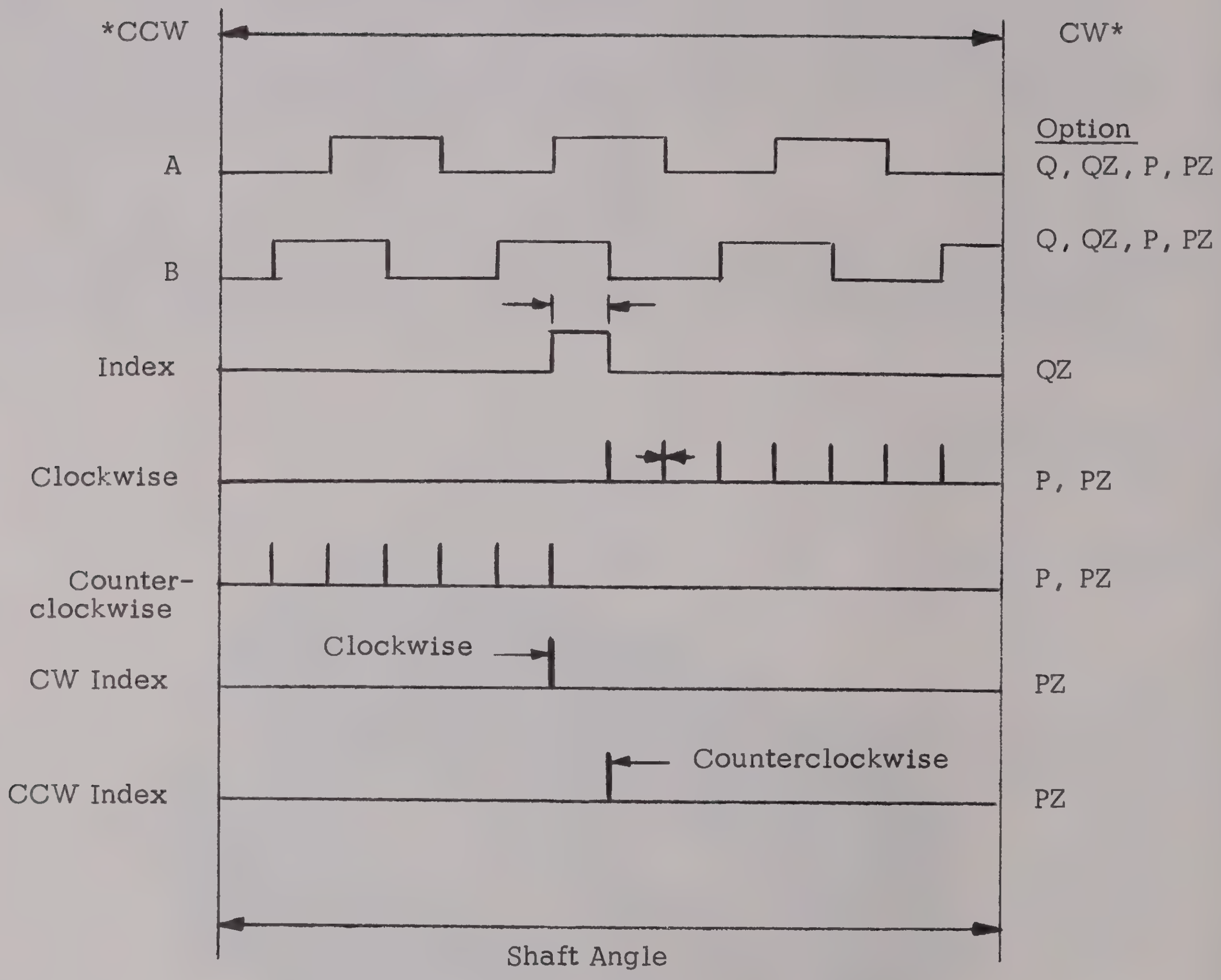
Rated Life

Electrical	20,000 hours minimum
Mechanical	10^9 revolutions minimum

*Refer to Section 5 for differences in models.

1/ On models with nonstandard voltages, the Logic "1" output voltage will be 0.5V less than +VDC.

2/ +6V available on special order.



*Defined looking at shaft extension end of encoder

Fig. 1-2 Output waveforms of DIGISEC RI __/35C series encoders

Table 1-2 Current Requirements for Standard DIGISEC RI__/35C Series Encoders

A-INCANDESCENT BULB MODELS

RI__/35C	+6 vdc Q	+6 vdc QZ	+6 vdc P	+6 vdc PZ	−6 vdc Q	−6 vdc QZ	−6 vdc P	−6 vdc PZ
13	300	350	330	380	15	30	15	30
14,15 20,000 to 50,000	540	590	570	620	15	30	15	30
16 64,000 to 100,000	595	645	625	675	45	60	45	60
17	650	700	680	730	75	90	75	90

Note: All current values are in milliamperes, maximum.

B - LED MODELS

RI 13,14,15 20,000 thru 50,000	+5 or +6V 1/ 400ma	All Options, W/X4 Multiplier
RI 16 64,000 thru 100,000	+6V, 675ma -6V, 60ma	All Options, W/X8 Multiplier
RI 17	+6V, 730ma -6V, 90ma	All Options, W/X16 Multiplier

1/ +5V standard; +6V on special order. See nameplate.

2. INSTALLATION AND OPERATION

2.1 HANDLING

DIGISEC RI__/35C series encoders are precision instruments and should be handled with care. Avoid shock to the encoder, particularly to the encoder shaft which is mounted on bearings to extremely fine tolerances. The plastic covering and the protective cap should remain in place during shipment or storage and should be removed only at the time that the encoder is installed in its operating location.

2.2 MECHANICAL ALIGNMENT

DIGISEC RI__/35C series shaft encoders are supplied in a synchro mount configuration, as shown in Fig. 2-1. Refer to Section 5 for outline dimensions of different models. The encoder may be installed in any attitude. However, the encoder shaft must be precisely aligned with the drive shaft because misalignment will degrade readout accuracy and shorten encoder life through excess loading of its bearings. The following precautions must be strictly adhered to.

Caution

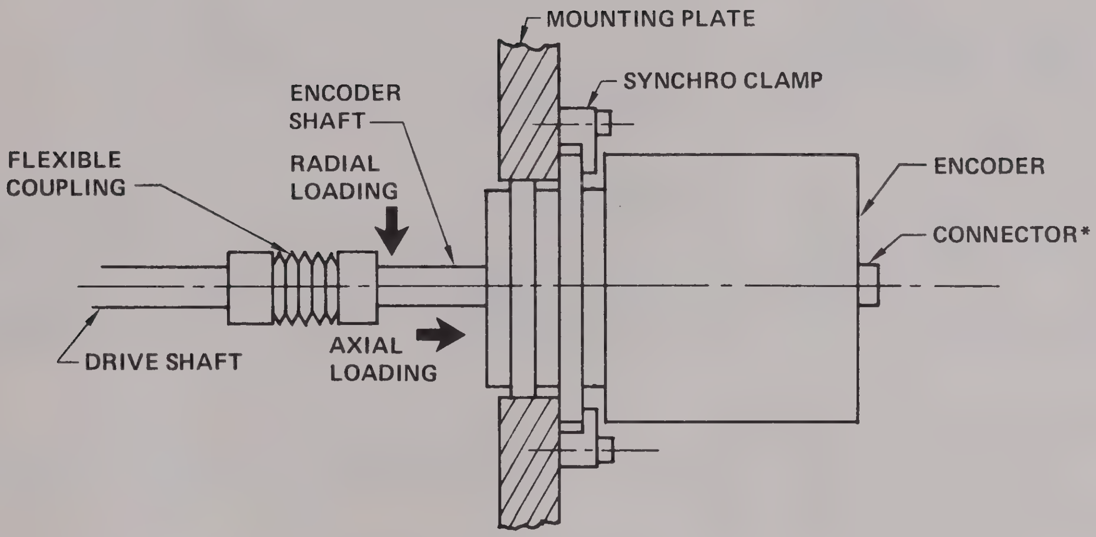
No alterations may be made to the encoder shaft or body except by the manufacturer, or warranty will be voided. Drilling or machining of the shaft will cause serious damage to the code disk, read-out optics, or bearings.

Caution

A flexible coupling of high angular accuracy (Kinnemotive Corporation, Kinneflex series, or equivalent) must be used between the drive shaft and the encoder shaft. Rigid couplings must not be used.

Caution

The alignment of the encoder must be such that axial and radial loading of the encoder shaft through the flexible coupling do not exceed the maximum loading specified for the shaft.



*MATING CONNECTOR SUPPLIED WITH ALL MODELS.

Fig. 2-1 — Installation of typical shaft encoder with synchro mount

The mounting hole must be bored to a diameter that is 0.001 inch (nominal) larger than the pilot diameter of the encoder. Concentricity of the pilot diameter hole with the drive shaft axis and perpendicularity of the mounting surface with that axis must be such that loading of the encoder shaft does not exceed the maximum limits specified in Table 1-1. Burring of mounting surfaces must be prevented because burring will prevent accurate alignment.

2.3 ELECTRICAL CONNECTIONS

Caution

Ensure that all power is shut off before removing or replacing interconnecting cables.

2.3.1 Connector Pin Functions

Refer to Section 5 for pin functions applicable to a particular encoder.

2.3.2 Grounding

Power and signal common are tied together within the encoder and are isolated from case ground since many applications require independent electrical and case grounds. To minimize noise problems, the noise level between the electrical and case grounds should be kept as low as possible. It is recommended that case ground be connected to electrical ground at only one point in the user's system, at a location to be determined experimentally for the particular installation.

2.3.3 Power Supply Considerations

The encoder electrical connector has +VDC sense and sense return pins, which are electrically tied to the +VDC and common terminals within the encoder* (see Fig. 2-2). These sense pins can be used in three ways:

1. For remote monitoring of +6-volt power supply voltage.
2. As sense lines for power supplies equipped with remote sense regulating circuits.
3. For paralleling supply lines to avoid power losses over long lines.

NOTE

The external power supplies must be set to provide +VDC† and -6 volts (± 2 percent, 1 percent peak to peak ripple) at the encoder connector to avoid erroneous readings caused by interconnection losses.**

2.4 ZERO INDEX ALIGNMENT

The following procedure may be used to align the QZ or PZ index with the drive shaft zero reference mark. The procedure is performed after the encoder is properly installed (Sections 2.2 and 2.3).

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*No −6-volt sense pin is provided because of the considerably lower current requirements at −6 volts. If desired, a −6-volt sense pin can be made by connecting any unused pin to the −6-volt pin near the mating connector.

† Encoders with nonstandard supply voltage requirements have the same tolerances.

**VDC is usually +5 or +6V. See model identification table in Section 5 and/or nameplate.

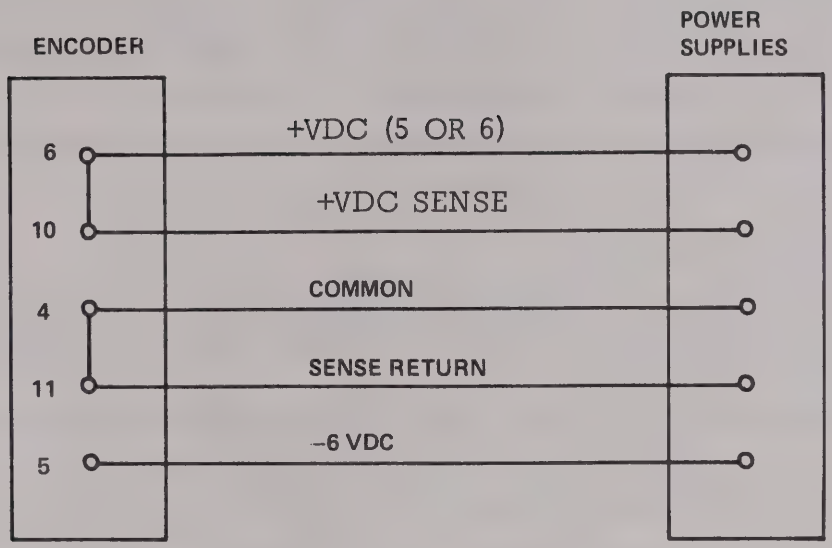


Fig. 2-2 — Remote sense wiring diagram

2.4.1 Test Equipment Required

A single-channel oscilloscope with dc-coupled input and 10-mhz bandwidth is required.

2.4.2 Initial Setup

NOTE

Use a flexible cable and connector when making electrical connections since the encoder case must be rotated to perform the index alignment.

Set up equipment as follows:

1. Ensure that the encoder power supplies are turned off and that all power, sense, and common lines are properly connected to the power supplies and the encoder.
2. Connect the oscilloscope to Z index output and signal common.
3. Set the oscilloscope to 2 volts per centimeter and sweep as indicated in paragraph 2.4.3 or 2.4.4, as applicable.

2.4.3 Alignment Procedure (QZ Option)

Align the equipment for the QZ option as follows:

1. Turn on the oscilloscope and set sweep to 5 milliseconds per centimeter, free running. Center the sweep line vertically.
2. Turn on the encoder power supplies and check that supply voltages are set correctly (see note, paragraph 2.3.3).
3. Loosen the flexible coupling at the encoder shaft.
4. Set the drive shaft (to be monitored) to zero reference.
5. Without disturbing the drive shaft position, slowly rotate the encoder shaft for coarse adjustment until the oscilloscope trace jumps up 2 to 3 centimeters momentarily.
6. Secure the flexible coupling to the encoder shaft.
7. Loosen the three synchro clamps securing the encoder to the mounting plate. Do not rotate the encoder case or shaft.
8. Reset the drive shaft to zero reference if necessary.

NOTE

In steps 9 through 12 ensure that the encoder shaft does not rotate.

9. Slowly rotate the encoder case until the oscilloscope sweep line jumps up 2 to 3 centimeters.
10. Slowly rotate the encoder case in the same direction until the sweep drops back to zero.
11. Slowly rotate the encoder case back and forth between the two points indicated in steps 5 and 6, and set it as close to the midpoint as possible (midpoint of square index pulse).
12. Tighten the three synchro clamps, ensuring that the encoder case is not rotated in the process.

13. Slowly rotate the drive shaft back and forth and check that the zero reference point still occurs at the midpoint of the square index pulse, as indicated by jumping of the oscilloscope sweep line. Repeat steps 3 through 9 if necessary.

2.4.4 Alignment Procedure (PZ Option)

Align the equipment for the PZ option as follows:

1. Turn on the oscilloscope and set the sweep to 5 microseconds per centimeter, internal trigger. Center the sweep line vertically.
2. Perform steps 2 through 4, paragraph 2.4.3.
3. Without disturbing the drive shaft position, slowly rotate the encoder shaft for coarse adjustment until a pulse (approximately 0.5 centimeter wide by 2 to 3 centimeters high) appears momentarily. Leave encoder shaft close to that position.
4. Perform steps 6 through 8, paragraph 2.4.3.

NOTE

In steps 5 through 8 ensure that the encoder shaft does not rotate.

5. Slowly rotate the encoder case until a pulse (approximately 0.5 centimeter wide by 2 to 3 centimeters high) appears and disappears as the encoder is rotated further in the same direction.
6. Slowly rotate the encoder case back until a second similar pulse appears and disappears.
7. Slowly rotate the encoder case back and forth between the two points indicated in steps 3 and 4 and set it as close to the midpoint as possible (between the clockwise and counterclockwise index pulses).
8. Tighten the three synchro clamps, ensuring that the encoder case is not rotated in the process.
9. Slowly rotate the drive shaft back and forth and check that the zero reference point still occurs at the midpoint between the clockwise and counterclockwise index pulses, as indicated on the oscilloscope. Repeat steps 2 through 7 if necessary.

2.5 OPERATION

After the encoder is properly installed and connected to a power source and to suitable output counting circuits, operation is entirely automatic. No adjustments or preventive maintenance are required aside from normal external cleaning procedures.

3. THEORY OF OPERATION

3.1 ROTATION DETECTION PRINCIPLE

Fig. 3-1 illustrates the rotation detection principle of DIGISEC rotary incremental encoders. The annular code pattern on the code disk is a continuous series of alternating transparent and opaque segments of equal width. Several precisely registered optical slits are stationed on the opposite side of the code pattern from the illuminating lamps, and photodetectors located directly behind the slits respond only to illumination passing through their respective slits. As the disk rotates, the illumination on a photodetector is modulated by the code pattern, and the detector produces a correspondingly modulated electrical output. By a suitable combination of code disk element shape, readout slit configuration, and photosensing geometry, the electrical output signal is made to be sinusoidal, with a period corresponding to one cycle on the code pattern (one clear and one opaque segment), as shown in Fig. 3-2a. It should be noted that the sinusoidal detector output is a function of angle, not time. The frequency of the detector output (cycles per second) is a function of the angular velocity of the encoder shaft.

Fig. 3-1 shows three slit-detector combinations, providing a sine, cosine, and index output. The sine and cosine detectors both read the annular code pattern and provide sinusoidal outputs, except that the cosine slit-photodetector is located n + 1/4 code cycles away from the sine slit and therefore produces a signal which leads the sine signal by 90 degrees (Fig. 3-2b). Combination of the sine and cosine signals through vector addition and logic operations enables a four-fold, eight-fold, or sixteen-fold increase in angular resolution over that possible with the sine signal alone (an encoder quantum resolution of 1/4, 1/8, or 1/16 code cycle is achieved, depending on the particular encoder). For example, a 16-bit (65,536-count) encoder containing a ×8 "multiplier" has a code disk with 8,192 cycles per revolution. The value of the multiplier used in the encoder (×4, ×8, ×16) indicates the number of clockwise (CW) or counterclockwise (CCW) pulses, or the combined number of transitions of the quadrature (A and B) square waves, per code cycle.

The zero index output signal (found in the QZ and PZ options only) occurs once per revolution of the encoder shaft and is used for position reference or for counting revolutions. The code disk contains a transparent index segment, near the code pattern annulus, which allows illumination to strike the index slit-detector combination once per revolution. The index detector output pulse is gated with precisely synchronized square waves to provide a narrow index pulse consistent with the resolution multiplier used in the encoder.

3.2 SIGNAL PROCESSING CIRCUITS

A general functional block diagram of the signal processing circuits, applicable to all encoders in this series, is shown in Fig. 3-3. The block diagram can be broken down into three functional groups: a quadrature square-wave generating circuit (all options), a CW and CCW pulse generating circuit (P and PZ options only), and an index circuit (QZ and PZ options only).

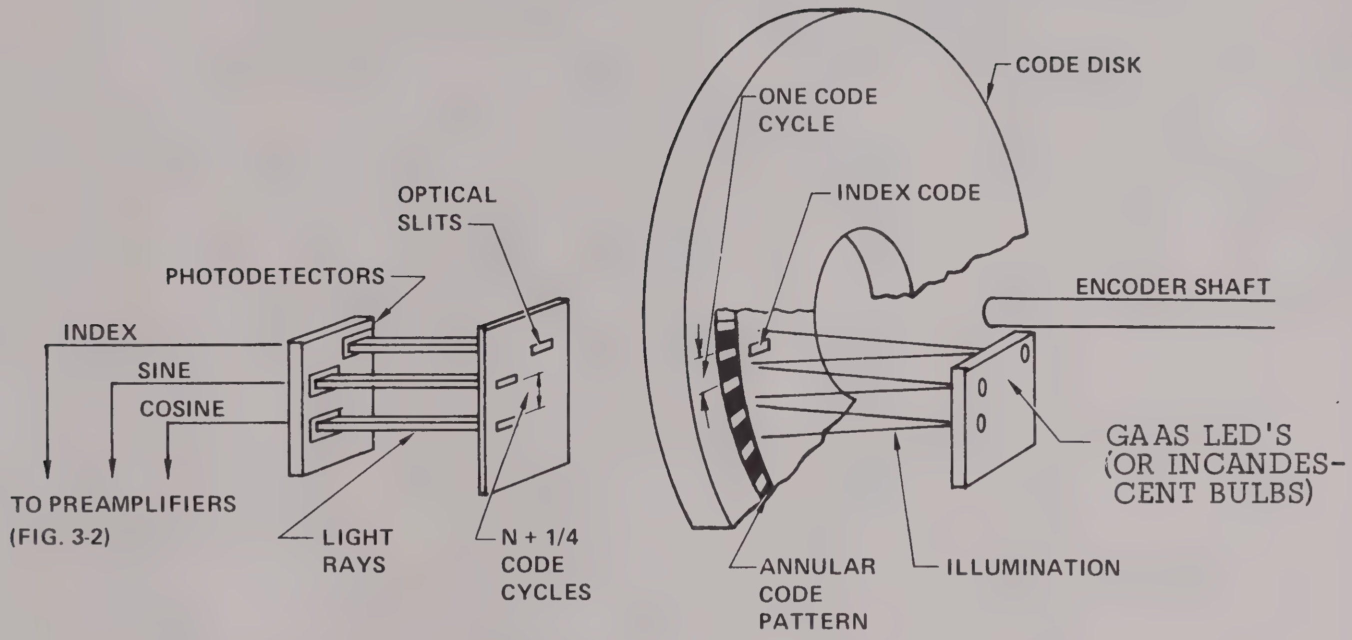


Fig. 3-1 — Rotation detection principle

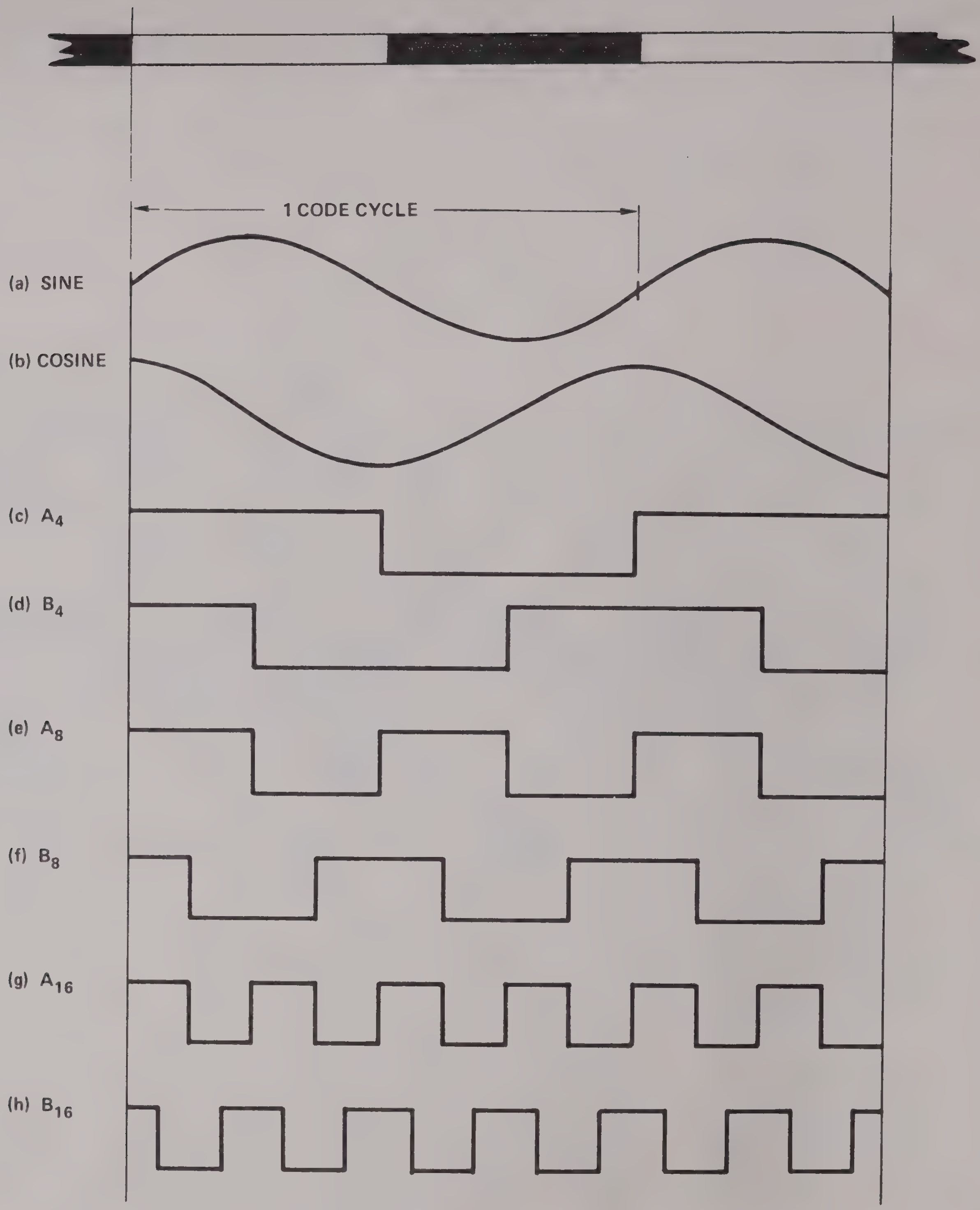
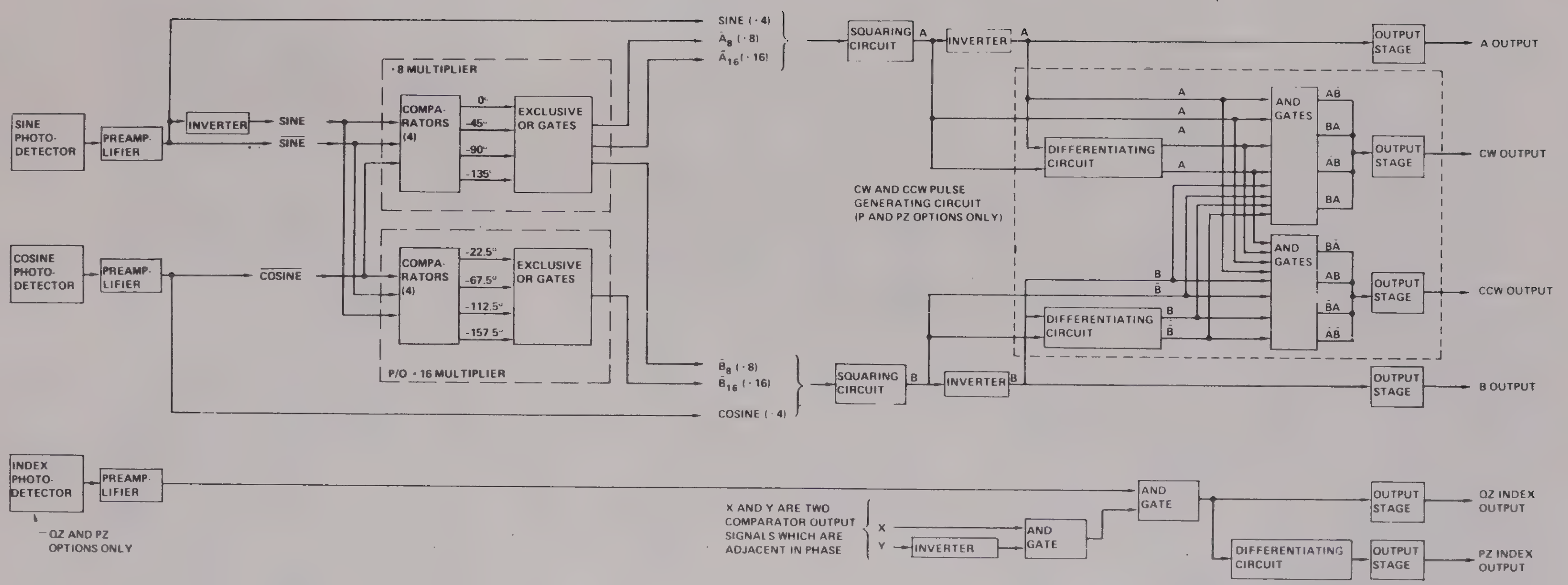


Fig. 3-2 — Photodetector and square-wave output signals



NOTE: OUTPUT STAGE: SN5417 TTL

Fig. 3-3 — Signal processing circuits, functional block diagram

3.2.1 Quadrature Square Wave Generating Circuit

This circuit generates the A and B output square waves, which have the following properties: A and B have the same frequency, with B leading A by 1/4 cycle, and the leading edge of A coincides with the positive-going transition of the sine photodetector output. The frequency of the quadrature waves relative to the code pattern frequency depends on whether the multiplier used is ×4, ×8, or ×16. With the ×4 multiplier there is a 1:1 correspondence between each code cycle and each square-wave cycle. When the ×8 and ×16 multipliers are used, there are two and four square-wave cycles, respectively, for each code cycle. In the discussion and illustrations, the A and B square waves are specified A_4 and B_4, A_8 and B_8, or A_{16} and B_{16} to specify whether they were derived through ×4, ×8, or ×16 multipliers (Fig. 3-2).

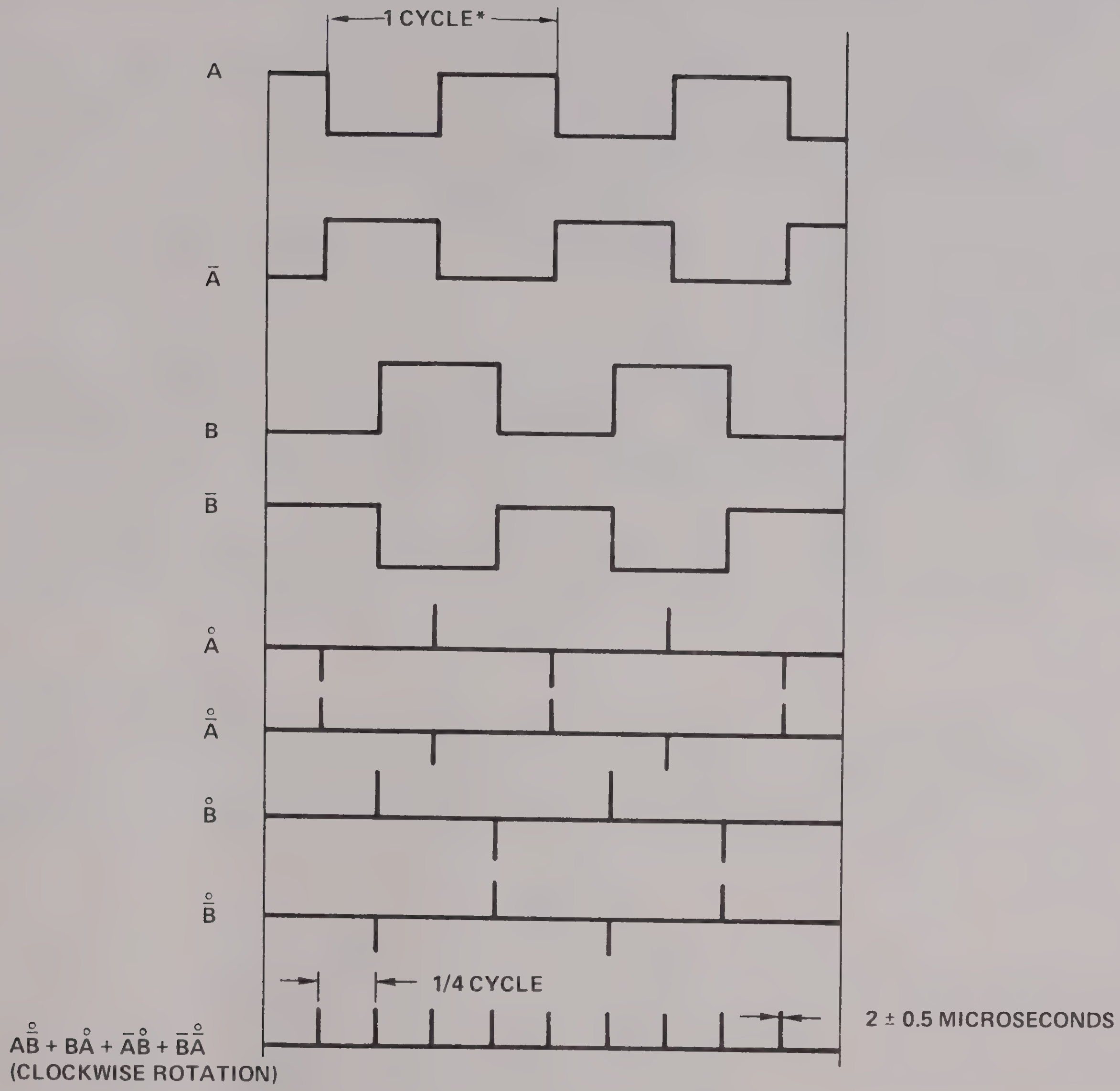
The basic square-wave generating circuit common to the three multipliers consists of the sine and cosine photodetectors, each followed by a preamplifier, a squaring circuit, an inverter, and a buffer amplifier output stage. Hysteresis is used in the squaring circuits to eliminate possible output transitions which might occur through vibration of the equipment.

With the ×4 multiplier, the two preamplifiers are operated in a saturated mode. The sinusoidal photodetector outputs are amplified and clipped to approximate two inverted square waves ($\overline{\text{SINE}}$, $\overline{\text{COSINE}}$), which are shaped by the two squaring circuits to produce $\bar{A}_4$ and $\bar{B}_4$. Inverted, these two signals become the required A_4 and B_4 quadrature square waves.

A_8/B_8 and A_{16}/B_{16} are generated by inserting ×8 and ×16 multipliers, respectively, between the preamplifers and the squaring circuits. The preamplifiers are operated in a linear mode to preserve the sinusoidal shape of the photodetector outputs. In addition, a linear inverter is used to provide a SINE signal from the $\overline{\text{SINE}}$ signal. These three sinusoids (SINE, $\overline{\text{SINE}}$, $\overline{\text{COSINE}}$) are brought to the multiplier comparators in various combinations and with various weighting factors. The output of each comparator is a square wave whose leading edge lags the 0-degree reference by the phase indicated in Fig. 3-3. Each square-wave cycle at the comparator outputs still corresponds to one code cycle. The leading edge of the 0-degree square wave coincides with the positive-going transition of the sine photodetector output. Frequency multiplication is achieved by operating on various combinations of comparator outputs with exclusive OR's to provide $\bar{A}_8$ and $\bar{B}_8$, or $\bar{A}_{16}$ and $\bar{B}_{16}$, according to the multiplier used. These signals are then fed to the two squaring circuits and, inverted, become the required A_8 and B_8, or A_{16} and B_{16}, quadrature square waves.

3.2.2 CW and CCW Pulse Generating Circuit

The CW and CCW pulse generating circuit operates on the quadrature square waves (A, B) and their inverse ($\bar{A}$, $\bar{B}$) to provide one narrow pulse for each quarter-cycle of a square wave. Two differentiating circuits provide $\mathring{A}$, $\mathring{\bar{A}}$, $\mathring{B}$, and $\mathring{\bar{B}}$. Suitable combinations of these eight signals are then fed to two sets of AND gates. The four outputs of each set of AND gates are tied to provide a logical OR path, and the two resulting pulse trains, amplified, become the required CW and CCW outputs. The narrow spikes representing the derivatives of the square waves are gated in the middle of the half-cycle of each square wave. Thus, the CW or CCW output pulse train contains one narrow pulse every 1/4 square-wave cycle (Fig. 3-4). The pulse width, unlike the square-wave width (in time), is not a function of the angular velocity of the encoder shaft, but is constant at 2 ± 0.5 microseconds. The combinations of signals to the AND gates are such that during clockwise rotation all pulses are gated through the CW channel. During counterclockwise rotation all pulses are gated through the CCW channel. Hysteresis is incorporated so that during a reversal of shaft rotation the counting circuits of the external data handling equipment will not drop the initial reverse count.



NOTE: COUNTERCLOCKWISE OUTPUT CAN BE DERIVED SIMILARLY.

*EQUALS ONE CODE CYCLE FOR ×4 MULTIPLIER, 1/2 CODE CYCLE FOR ×8 MULTIPLIER, AND 1/4 CODE CYCLE FOR ×16 MULTIPLIER.

Fig. 3-4 — Derivation of clockwise and counterclockwise outputs from A and B quadrature square waves

3.2.3 Index Circuit

The index circuit, shown at the bottom of Fig. 3-3, provides one zero index pulse for each revolution of the encoder shaft. For the QZ option, this circuit consists of the index photodetector, a preamplifier, two AND gates and an inverter, and an output stage. The index circuit for the PZ option is similar, but a differentiating circuit precedes the output stage.

The QZ index pulse is 1/4 square-wave cycle wide; its leading and trailing edges coincide with successive edges of the two quadrature square waves (A and B), as shown in Fig. 1-2. The signal from the index photodetector is approximately one code cycle wide. After being amplified and clipped by the preamplifier, this signal is gated by a narrower pulse which ensures that the width and coincidence of the output index pulse is as described above. The gating pulse, whose width must vary with the multiplier used, is derived by AND gating two comparator output signals which are adjacent in phase, one signal being inverted. The phase difference between the two comparator outputs selected is either 90 degrees (×4 multiplier), 45 degrees (×8 multiplier), or $22\frac{1}{2}$ degrees (×16 multiplier).

The PZ index pulse is derived by differentiating the QZ index pulse. The differentiating circuit is clamped to provide an output only on the leading edge of the square wave (positive derivative). Therefore, the CW and CCW index pulses (both 2 ± 0.5 microseconds wide) are generated on opposite edges of the QZ index pulse and are separated by 1/4 square-wave cycle.

4. MAINTENANCE

4.1 SCOPE

Because DIGISEC RI___/35C series encoders are factory aligned and calibrated to extremely high precision, field maintenance is restricted to external cleaning and minor troubleshooting. Field lubrication is not necessary. The troubleshooting instructions which follow should help in isolating failure to the encoder or the external equipment. If a failure is diagnosed in the internal electrical or mechanical functioning of the encoder, no attempt should be made to correct the malfunction by opening the encoder or forcing rotation of the shaft. A detailed description of failure symptoms, suspected malfunctions, and operating conditions should be made. The encoder should then be carefully decoupled and removed from its mount, packed with its protective cap, plastic covering and failure description, and returned to the manufacturer for repair.

4.2 TROUBLESHOOTING

The troubleshooting table (Table 4-1) should be used as an aid in isolating malfunctions which may occur during operation of the encoder. Locate the observable malfunction in the Symptom column. The Probable Cause column identifies the most probable or most readily checked failure. The appropriate corrective action is listed in the last column.

NOTE

> The external power supplies must be set to provide +VDC* and -6V (± 2 percent, 1 percent peak to peak ripple) at the encoder connector to avoid erroneous readings caused by interconnection losses.

The A and B output tests (Section 4.3) referenced in Table 4-1 are used to check that the amplitude, phasing, and symmetry of the A and B outputs are within acceptable tolerance. Since the clockwise and counterclockwise outputs (P and PZ options) are derived from the A and B signals, these tests also help to isolate the cause of failure if the clockwise or counterclockwise output signals are incorrect.

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*Encoders with nonstandard supply voltage requirements have the same tolerances.

Table 4-1 — Troubleshooting

Item	Symptom	Probable Cause	Corrective Action
1	No output signal(s)	a. No power from external power supplies, or incorrect supply voltages	a. Check power supply for proper voltages (see note, Section 4.2)
		b. Loose coupling to encoder or drive shaft, or frozen drive shaft	b. Check coupling and tighten if necessary; check drive shaft
		c. Encoder output shorted either in cable or external load circuits	c. Disconnect load circuits from encoder; check for presence of output signals at encoder connector with oscilloscope
		d. Defective encoder component(s) (lamps, photodetectors, circuitry)	d. Replace encoder
2	Encoder shaft binds	Defective encoder bearings or code disk through misalignment	Replace encoder, correcting alignment (refer to Section 2.2)
3	Multiple index zero signals	a. Power supply voltages out of tolerance	a. Same as item 1a
		b. Defective or misaligned encoder components	b. Replace encoder
4	Incorrect output voltages; improper phasing between A and B outputs; assymmetry in A or B output; or wrong or reversed counts on clockwise and counterclockwise outputs (refer to Section 4.3 for A and B output tests)	a. Power supply voltages out of tolerance	a. Same as item 1a
		b. Case ground open	b. Check that case ground is tied to power and signal common (at one point) on external equipment
		c. Defective or misaligned encoder components (bearings, code disk, trimming circuits)	c. Replace encoder

4.3 A AND B OUTPUT TESTS

4.3.1 Purpose

The A and B output tests are used to check that the amplitude, phasing, and symmetry of the A and B quadrature square-wave outputs are within acceptable tolerance.

4.3.2 Test Equipment Required

A dual-channel oscilloscope with 1-mhz bandwidth is required.

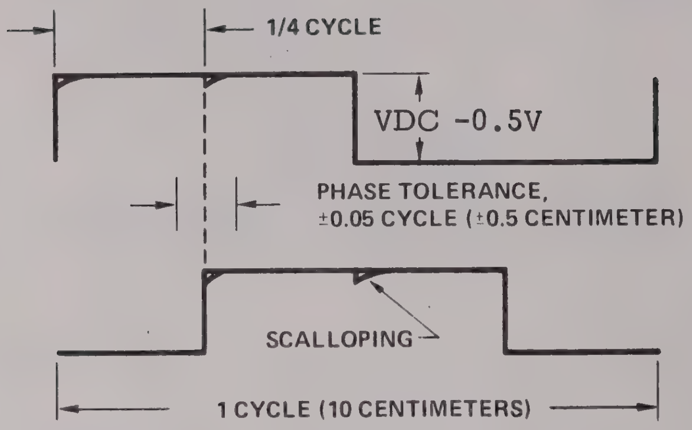
4.3.3 Test Procedure

Caution

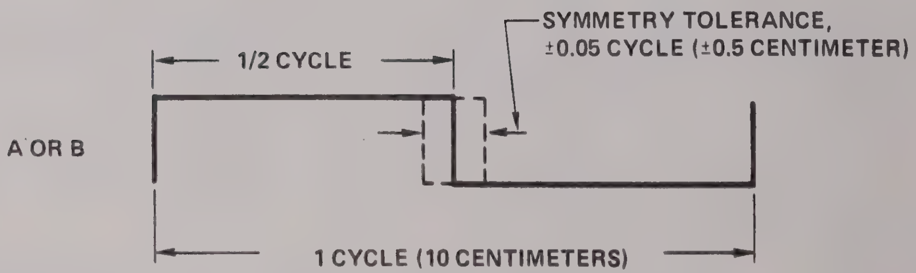
Ensure that all power is removed from the encoder before connecting or disconnecting test leads.

Test the equipment as follows:

1. Connect the oscilloscope channel A to the A output of the encoder and channel B to the B output (see Table 5-2 for electrical connections).
2. Check that encoder power supplies are turned off and that all power, sense, and common lines are properly connected to the power supplies and the encoder.
3. Turn on the encoder power supplies and check that supply voltages are set correctly (see note, Section 4.2).
4. Check that the drive shaft is rotating.
5. Set the oscilloscope vertical sensitivities to 2 volts per centimeter, ac coupled, on both channels. Set the horizontal sweep (internal trigger) so that one full cycle of the A square wave is displayed across 10 centimeters, as shown in Fig. 4-1.
6. Check that the A and B square waves have the correct amplitude (+VDC, +0, -0.5V).
7. Check that the phasing of the B square wave relative to the A square wave is within the tolerance indicated in Fig. 4-1a.
8. Check that the symmetry of the A square wave is within the tolerance indicated in Fig. 4-1b.
9. Center the B square wave horizontally and check that its symmetry is within the tolerance indicated in Fig. 4-1b.
10. Turn off the encoder power supplies and disconnect the test leads.



(a) Phase tolerance



NOTE: SCALLOPING SHOWN OCCURS ONLY IN P AND PZ OPTIONS.

(b) Symmetry tolerance

Fig. 4-1 — Phase and symmetry tolerances of A and B outputs

5. DIFFERENCES IN MODELS

This section contains detailed specifications for all DIGISEC RI__/35C series encoders in addition to those general specifications listed in Table 1-1.

5.1 IDENTIFICATION OF ENCODERS

DIGISEC encoders are identified by type number and part number. The type number gives the major encoder characteristics as follows:

RI(a)/35C(b)

where R = rotary
I = incremental
(a) = resolution (see Table 5-1 or 5-3, column 1)
35 = 3.5-inch diameter
C = Contained electronics
(b) = output option (Q, QZ, P, or PZ; see Table 5-1 or 5-3, column 1)

The part number completely specifies the encoder.

5.2 BREAKDOWN OF STANDARD AND NONSTANDARD ENCODERS (INCANDESCENT ILLUMINATION)

Table 5-1 identifies the standard RI__/35C series encoders in terms of their type number, part number, resolution, multiplier, and maximum operating speed. Table 5-3 also lists any deviations (length, supply voltages, temperature range, electrical connections, etc.) found in nonstandard encoders of that series.

Connector pin functions for standard encoders are listed in Table 5-2, which also identifies lead colors for those nonstandard encoders with an optional standard connector or pigtail (see Table 5-3). Electrical connections for other nonstandard encoders can be found in Table 5-4, by encoder part number.

Fig. 5-1 and Table 5-5 provide outline dimensions for standard RI__/35C series encoders. Differences in dimensions are listed in Table 5-3.

5.3 BREAKDOWN OF STANDARD AND NONSTANDARD ENCODERS (GA AS LED ILLUMINATION)

Table 5-6 identifies all GaAs LED standard models. Outlines and pin functions are shown on drawing C2000-631 which follows Page 33. Table 5-7 identifies all GaAs LED nonstandard models.

Table 5-1 – Detailed Specifications for Standard DIGISEC RI__/35C Series Encoders
Incandescent Bulb Illumination

DIGISEC Type Number (RI__/35C__)	Part Number (2771-)	Angular Resolution	Pulses Per Revolution (Note 4)	Multiplier	Maximum Operating Speed, rpm
13 P	1	2.64 minutes	2^{13}	×4	750
13 PZ	2				
13 Q	3				
13 QZ	4				
14 P	5	1.32 minutes	2^{14}	×4	375
14 PZ	6				
14 Q	7				
14 QZ	8				
15 P	9	39.6 seconds	2^{15}	×4	180
15 PZ	10				
15 Q	11				
15 QZ	12				
16 P	13	19.8 seconds	2^{16}	×8	140
16 PZ	14				
16 Q	15				
16 QZ	16				
17 P	17	9.9 seconds	2^{17}	×16	70
17 PZ	18				
17 Q	19				
17 QZ	20				
20K P	21	1.1 minutes	20,000	×4	300
20K PZ	22				
20K Q	23				
20K QZ	24				
32K P	25	40.5 seconds	32,000	×4	180
32K PZ	26				
32K Q	27				
32K QZ	28				
36K P	29	36.0 seconds	36,000	×4	160
36K PZ	30				
36K Q	31				
36K QZ	32				
40K P	33	32.4 seconds	40,000	×4	150
40K PZ	34				
40K Q	35				
40K QZ	36				
50K P	37	25.9 seconds	50,000	×4	120
50K PZ	38				
50K Q	39				
50K QZ	40				
64K P	41	20.2 seconds	64,000	×8	100
64K PZ	42				
64K Q	43				
64K QZ	44				
72K P	45	18.0 seconds	72,000	×8	80
72K PZ	46				
72K Q	47				
72K QZ	48				
80K P	49	16.2 seconds	80,000	×8	75
80K PZ	50				
80K Q	51				
80K QZ	52				
100K P	53	12.96 seconds	100,000	×8	60
100K PZ	54				
100K Q	55				
100K QZ	56				

Notes (all models):

1. Other specifications listed in Table 1-1.
2. Outline dimensions shown in Fig. 5-1.
3. Electrical connections listed in Table 5-2.
4. The term transition should be substituted for pulse for proper definition of parameters related to options Q and QZ. Transitions are defined as the square-wave edges, both rising and falling. Thus, a DIGISEC RI20K/35CQ encoder contains 5,000 full square-wave cycles on each of the two output channels. The number of transitions is 20,000.

Table 5-1 — Detailed Specifications for Standard DIGISEC RI__/35C Series Encoders (Cont.)

DIGISEC Type Number (RI__ 35C__)	Part Number (2771-)	Angular Resolution	Pulses Per Revolution (Note 4)	Multiplier	Maximum Operating Speed, rpm

Additional data will be supplied as more units become available.

Table 5-2 — Electrical Connections for Standard DIGISEC RI___/35C Series Encoders
(Incandescent Bulb Models)

Pin Number	Output Option P	Output Option PZ	Output Option Q	Output Option QZ	Pigtail Lead Color*
1	CCW output	CCW output	Spare	Spare	Brown
2	CW output	CW output	Spare	Spare	Yellow
3	Spare	Index pulse	Spare	Index gate	Green
4	Common	Common	Common	Common	Black
5	−6 vdc	−6 vdc	−6 vdc	−6 vdc	Violet
6	+6 vdc	+6 vdc	+6 vdc	+6 vdc	White
7	Case ground	Case ground	Case ground	Case ground	Wht/Blk
8	Output A	Output A	Output A	Output A	Red
9	Output B	Output B	Output B	Output B	Orange
10	+6-volt sense	+6-volt sense	+6-volt sense	+6-volt sense	Gray
11	+6-volt sense return	+6-volt sense return	+6-volt sense return	+6-volt sense return	Wht/Gry
12	Spare	Index gate	Spare	Spare	
13	Spare	Spare	Spare	Spare	
14	Spare	Spare	Spare	Spare	
15	Spare	Spare	Spare	Spare	

* For those nonstandard encoders having the same pin functions and a pigtail option (Table 5-3).

Table 5-3 — Detailed Specifications for Nonstandard DIGISEC RI__ 35C Series Encoders (Incandescent Bulb Models)

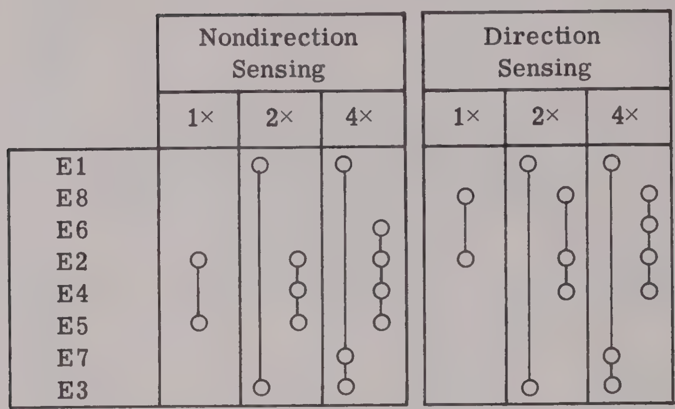
DIGISEC Type Number (RI__/35C__)	Part Number	Angular Resolution	Pulse Per Revolution (Note 4, Table 5-1)	Multiplier	Maximum Operating Speed, rpm	Supply Voltages, vdc (Note 2)	Electrical Connections (Note 3)	Maximum Length, inches (Note 4)	Miscellaneous
14 PZ	2584	1.32 minutes	2^{14}	×4	375		Table 5-4	2.9	25-pin connector for 1×, 2×, or 4× multiplier option, temperature 0 to 70°C
14PZ	2746	1.32 minutes	2^{11}	×4	375			2.9	
15 QZ	2718	39.6 seconds	2^{15}	×4	180			3.0	
17 QZ	2716	9.9 seconds	2^{17}	×16	70	+6, −6, +12	Table 5-4	3.0	
10K P	2799	2.2 minutes	10,000	×2	300			3.0	
20K QZ	2717	1.1 minutes	20,000	×4	300			3.0	
36K PZ	2555	36.0 seconds	36,000	×4	160			2.9	
36K P	2737	36.0 seconds	36,000	×4	160			2.9	
40K QZ	2649	32.4 seconds	40,000	×4	150	+4.5, −10		2.9	0.25-inch-diameter shaft
50K PZ	2724	25.9 seconds	50,000	×4	120			2.5	Pigtail with connector
80K P	2583	16.2 seconds	80,000	×16	1,125	+6, −6, +12	Table 5-4	2.9	Customer specification no. 10378, 0.16 ± 0.02-microsecond pulse
80K P	2679	16.2 seconds	80,000	×16	75	+6, −6, +12	Table 5-4	2.9	
100K P	2788	13.0 seconds	100,000	×8	90			3.0	Pigtail with connector
16CQPZ	2803	19.8 sec.	2^{16}	x8	140	+6, -6,		4.0	30" Pigtail w/connector
36K CQZ	2821	36.0 sec.	36,000	x4	160			3.0	24" Pigtail
36K CQZX	2827	36.0 sec.	36,000	x4	160		Table 5-4	4.0	Special shaft, Nat'l Semi. DM7830 output line drivers
36K CPZ	2771-30X, 2732-70	36.0 sec.	36,000	x4	160			3.0	Special Flat On Shaft
128K CQPZ	2771-18X, SK10494	10.125 sec.	128,000	x16	70				Similar to 2771-18

Additional data will be supplied as more units become available.

NOTES:
1. Other specifications listed in Table 1-1.
2. +6 vdc, −6 vdc ± 2 percent, 1 percent peak to peak ripple, unless otherwise specified.
3. Cannon DA15P connector with standard pin functions, or optional pigtail with standard lead colors, as listed in Table 5-2, unless otherwise specified.
4. Corresponds to dimension A in Fig. 5-1. Other dimensions as in Fig. 5-1 unless otherwise specified.

Table 5-4 — Nonstandard Electrical Connections*
(Incandescent Bulb Models)

P/N	Pin Number	Pigtail	Function
2716:	14	Blue	+12 vdc
2583, 2679:	10	Gray	CCW return
	11	Wht/Gry	CW return
	14	Blue	+12 vdc
2584:	10	Black	Power common
(Cannon DA25P	11		+6-vdc sense
connector)	12		Sense return
	13	Wht/Brn	E1†
	19	Wht/Gry	E8†
	20	Wht/Blu	E6†
	21	Wht/Red	E2†
	22	Wht/Yel	E4†
	23	Wht/Grn	E5†
	24	Wht/Vio	E7†
	25	Wht/Orn	E3†



2827:
Cannon DA15/P wired as follows:

Pin No.	Function	Pin No.	Function
1	A Output	8	B Output
2	$\overline{A}$ Output	9	N.C.
3	N.C.	10	+6V Sense
4	Common	11	+6V Sense Return
5	-6VDC Input	12	Z Index Gate
6	+6VDC Input	13	$\overline{Z}$ Index
7	Case Ground	14	N.C.
		15	$\overline{B}$ Output

*Other pin and pigtail functions as indicated in Table 5-2. Cannon DA15P connector unless otherwise specified.
†Connect jumpers across terminals, as indicated, for multiplier option desired.

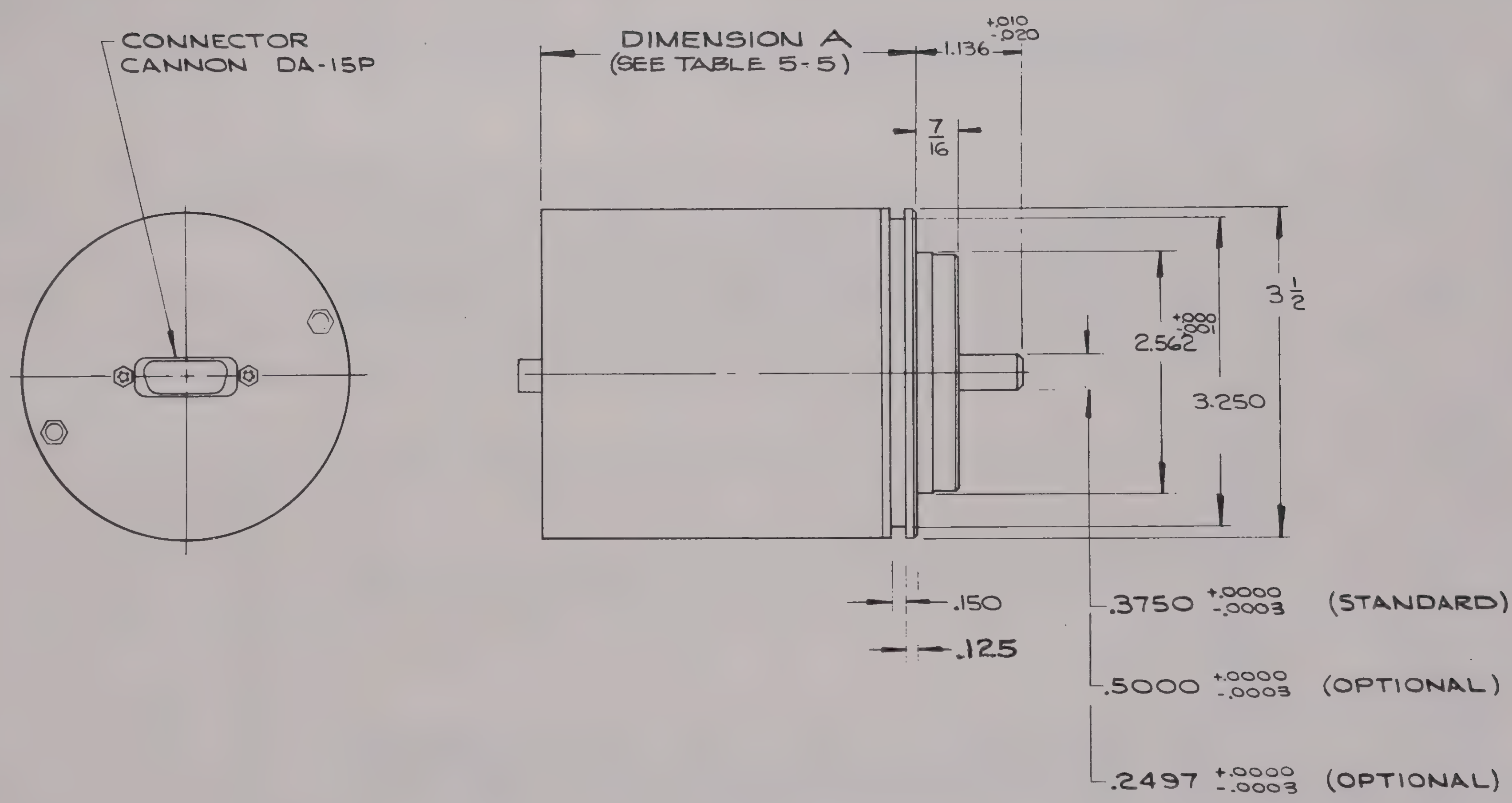


Fig. 5-1 — Outline dimensions of standard DIGISEC RI__/35C series encoders
Incandescent Bulb Models

Rev. 10/5/72

Table 5-5 — Dimension A for Standard DIGISEC RI__/35C Series Encoders*
Incandescent Bulb Models

Encoder Type	Dimension A	Encoder Type	Dimension A
RI 13/35P	3.00	RI 36K/35P	3.00
RI 13/35PZ	3.00	RI 36K/35PZ	3.00
RI 13/35Q	3.00	RI 36K/35Q	3.00
RI 13/35QZ	3.00	RI 36K/35QZ	3.00
RI 14/35P	3.00	RI 40K/35P	3.00
RI 14/35PZ	3.00	RI 40K/35PZ	3.00
RI 14/35Q	3.00	RI 40K/35Q	3.00
RI 14/35QZ	3.00	RI 40K/35QZ	3.00
RI 15/35P	3.00	RI 50K/35P	3.00
RI 15/35PZ	3.00	RI 50K/35PZ	3.00
RI 15/35Q	3.00	RI 50K/35Q	3.00
RI 15/35QZ	3.00	RI 50K/35QZ	3.00
RI 16/35P	3.00	RI 64K/35P	3.00
RI 16/35PZ	4.00	RI 64K/35PZ	4.00
RI 16/35Q	3.00	RI 64K/35Q	3.00
RI 16/35QZ	4.00	RI 64K/35QZ	4.00
RI 17/35P	4.00	RI 72K/35P	3.00
RI 17/35PZ	4.00	RI 72K/35PZ	4.00
RI 17/35Q	4.00	RI 72K/35Q	3.00
RI 17/35QZ	4.00	RI 72K/35QZ	4.00
RI 20K/35P	3.00	RI 80K/35P	3.00
RI 20K/35PZ	3.00	RI 80K/35PZ	4.00
RI 20K/35Q	3.00	RI 80K/35Q	3.00
RI 20K/35QZ	3.00	RI 80K/35QZ	4.00
RI 32K/35P	3.00	RI 100K/35P	3.00
RI 32K/35PZ	3.00	RI 100K/35PZ	4.00
RI 32K/35Q	3.00	RI 100K/35Q	3.00
RI 32K/35QZ	3.00	RI 100K/35QZ	4.00

*Dimension A is defined in Fig. 5-1.

Table 5-6 Detailed Specifications for 2885-__ DIGISEC RI __/35C Series Encoders
GaAs LED Illumination

DIGISEC Type Number (RI__ 35C__)	Part Number 2885-	Angular Resolution	Pulses per Revolution (Note 4)	Multiplier	Maximum Operating Speed, rpm	Voltage
13 QP	1	2.64 minutes	2^{13}	X4	750	+5 [5]
13 QPZ	2					
13 Q	3					
13 QZ	4					
14 QP	5	1.32 minutes	2^{14}	X4	375	+5 [5]
14 QPZ	6					
14 Q	7					
14 QZ	8					
15 QP	9	39.6 seconds	2^{15}	X4	180	+5 [5]
15 QPZ	10					
15 Q	11					
15 QZ	12					
16 QP	13	19.8 seconds	2^{16}	X8	140	±6
16 QPZ	14					
16 Q	15					
16 QZ	16					
17 QP	17	9.9 seconds	2^{17}	X16	70	±6
17 QPZ	18					
17 Q	19					
17 QZ	20					
20K QP	21	1.1 minutes	20,000	X4	300	+5 [5]
20K QPZ	22					
20K Q	23					
20K QZ	24					
32K QP	25	40.5 seconds	32,000	X4	180	+5 [5]
32K QPZ	26					
32K Q	27					
32K QZ	28					
36K QP	29	36.0 seconds	36,000	X4	160	+5 [5]
36K QPZ	30					
36K Q	31					
36K QZ	32					
40K QP	33	32.4 seconds	40,000	X4	150	+5 [5]
40K QPZ	34					
40K Q	35					
40K QZ	36					
50K QP	37	25.9 seconds	50,000	X4	120	+5 [5]
50K QPZ	38					
50K Q	39					
50K QZ	40					
64K QP	41	20.2 seconds	64,000	X8	100	±6
64K QPZ	42					
64K Q	43					
64K QZ	44					
72K QP	45	18.0 seconds	72,000	X8	80	±6
72K QPZ	46					
72K Q	47					
72K QZ	48					
80K QP	49	16.2 seconds	80,000	X8	75	±6
80K QPZ	50					
80K Q	51					
80K QZ	52					
100K QP	53	12.96 seconds	100,000	X8	60	±6
100K QPZ	54					
100K Q	55					
100K QZ	56					
200K QP	57	6.48 seconds	200,000	X16	60	±6
200K QPZ	58					
200K Q	59					
200K QZ	60					

Notes (all models):

1. Other specifications listed in Table 1-1.
2. Outline dimensions shown on drawing C2000-631.
3. Electrical connections listed on drawing C2000-631.
4. The term transition should be substituted for pulse for proper definition of parameters related to options Q and QZ. Transitions are defined as the square wave edges, both rising and falling. Thus, a DIGISEC RI 20K/35CQ encoder contains 5,000 full square wave cycles on each of the two output channels. The number of transitions is 20,000.
5. +6V available on special order.

Table 5-6 Cont'd. - Detailed Specifications for 2885-___ DIGISEC RI __/35C Series Encoders GaAs LED Illumination

DIGISEC Type Number (RI__ 35C__)		Part Number 2885-	Angular Resolution	Pulses per Revolution (Note 4)	Multiplier	Maximum Operating Speed, rpm	Voltage
128K	QP	61	10.1 Seconds	128,000	X16	60	± 6V
	QPZ	62					
	Q	63					
	QZ	64					
144K	QP	65	9.0 Seconds	144,000	X16	60	± 6V
	QPZ	66					
	Q	67					
	QZ	68					
160K	QP	69	8.1 Seconds	160,000	X16	60	± 6V
	QPZ	70					
	Q	71					
	QZ	72					

Table 5-7 - Detailed Specifications for Nonstandard DIGISEC RI __/35C Series Encoders
(GaAs LED Illumination)

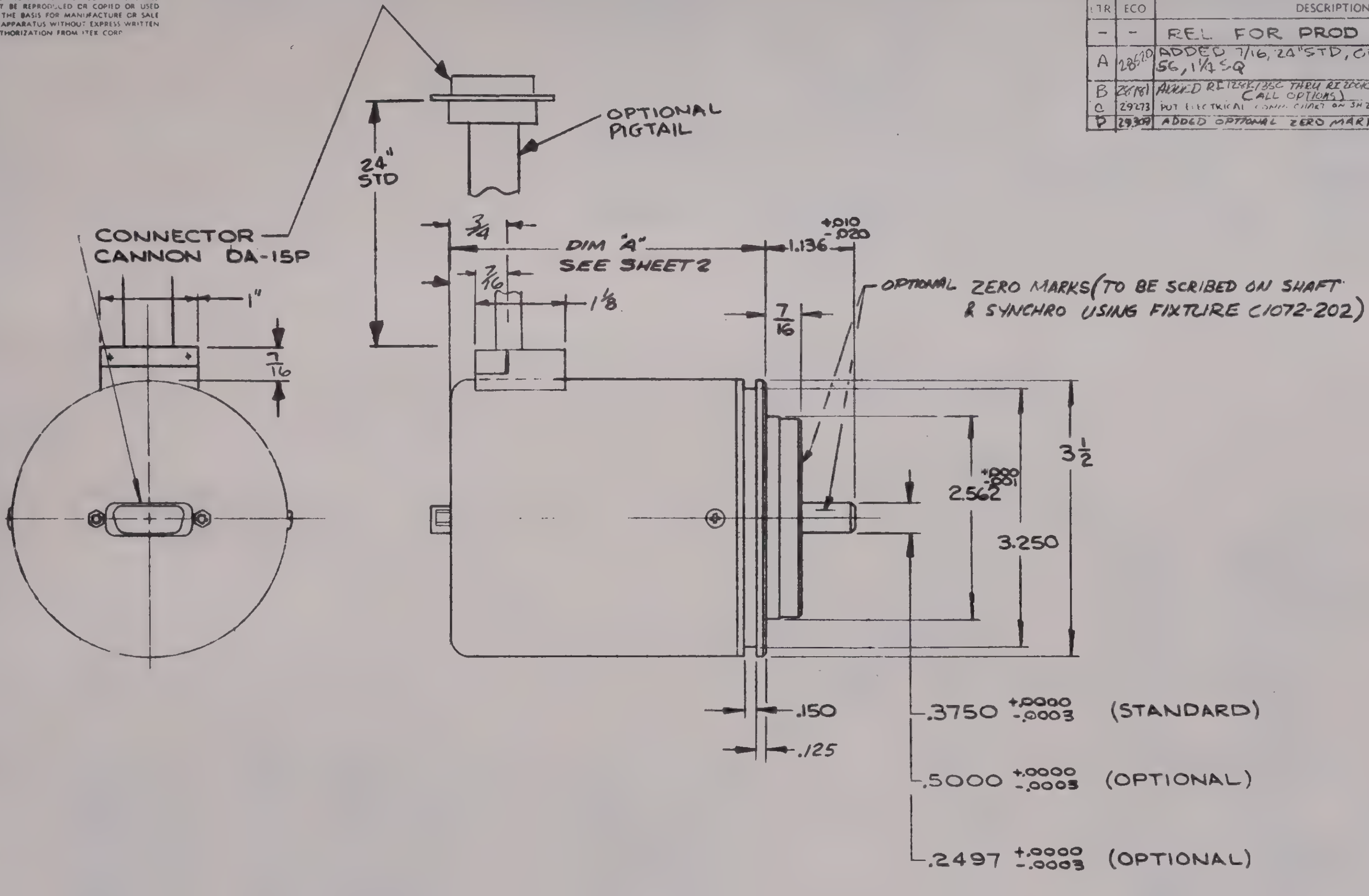
DIGISEC Type Number (RI __/35C __)		Part Number	Angular Resolution	Pulse per Revolution (Note 4, Table 5-1)	Multiplier	Maximum Operating Speed rpm	Supply Voltages, vdc (Note 2)	Electrical Connections (Note 3)	Maximum Length inches (Note 4)	Miscellaneous
15	PZX	2953	39.6 sec.	2^{15}	X4	180	+5 @ 750MA max.		3.00	-30 to +74°C, DM7830 line drivers, shaft seal kit, MS connector Gilfillan Spec. G300401
12	PZX	2958	5.27 min.	2^{12}	X1	575	+5		3.00	4 station, 10°C to 27°C, 24 inch plain pigtail, Itek OSD Specification 220023P1"B"
13	PX	2967	2.64 min.	2^{13}	X2	1000			3.00	Bidirectional output, 1/2 inch shaft, special preamp, sine only
64K	QPZX	2973	20.2 sec.	64,000	X8	100			3.149	24 inch pigtail w/connector, non-magnetic base and shaft
16	QPZ	2887-141	19.8 sec.	2^{16}	X16	300			4.00	4096 cycle code disc, output pulse 0.75 µsec., zero stable at 300 RPM
36K	QPZX	2887-181	36.0 sec.	36,000	X4	100			3.00	Operating temp. 0 to 150°F, standard connector with locking screw assy. M24308-26-1, C2887-166

Additional data will be supplied as more units become available

NOTES:
1. Other specifications listed in Table 1-1.
2. +6 vdc, -6 vdc ± 2 percent, 1 percent peak to peak ripple, unless otherwise specified.
3. Cannon DA15P connector with standard pin functions, or optional pigtail with standard lead colors, as listed in Table 5-2, unless otherwise specified.
4. Corresponds to dimension A in Fig. 5-1. Other dimensions as in Fig. 5-1 unless otherwise specified.

REVISIONS

LTR	ECO	DESCRIPTION	DATE	CHKR-APVD
-	-	REL FOR PROD	9/14/73	RP
A	28620	ADDED 7/16, 24"STD, OPTIONAL PIGTAIL 56, 1 1/4 SQ	[illegible]	RP
B	28781	ADDED RI12__/35C THRU RI2000/35C & DIM A 4.00 (CALL OPTIONS)	WMC	RP
C	29273	PUT ELECTRICAL CONN CHART ON SH 2, [illegible] SEE ECS	[illegible]	HP
D	29309	ADDED OPTIONAL ZERO MARKS	[illegible]	RP



NOTES:

1) PIN 5 NOT CONNECTED FOR ENCODER TYPE'S MARKED ✱ ON SHT 2 THIS DWG.
2) PIN 6 IS + 5VDC FOR ENCODER TYPE'S MARKED ✱ ON SHT 2 THIS DWG.
3) FOR ELECTRICAL CONNECTIONS SEE SHEET 2.

GI QTY	ITEM NO	PART NO	DESCRIPTION	MATERIAL	SPECIFICATION	CODE IDENT

LIST OF MATERIAL

SCD2885	
NEXT ASSY	
APPLICATION	

UNLESS OTHERWISE SPECIFIED

ALL DIMENSIONS ARE IN INCHES DIM. AND TOL. PER USA STD Y14.5 DIM. APPLY AFTER PROCESSING

TOLERANCES
2 PLACE DEC ± .010 FRAC ± 1/64
3 PLACE DEC ± .005 DEG ± 30 MIN.

SURFACE ROUGHNESS PER USA STD B46.1

BREAK SHARP EDGES AND CORNERS .005 TO .020 RADIUS

MATERIAL N/A

FINISH N/A

		DATE
DWN	Tail Tabar	9-4-73
CHKR	RP	9/4/73
ENGR	[illegible]	[illegible]
QA	[illegible]	[illegible]
APVD	[illegible]	9/10/73

Itek WAYNE-GEORGE DIVISION
NEWTON, MASSACHUSETTS U.S.A.

ENCODER RI __/35C OUTLINE

SIZE	CODE IDENT NO		REV
C	06130	2000-631	D

SCALE 1/1 WT SHEET 1 OF 2

C 2000-631

C 2000-591

REVISIONS				
LTR	ECO	DESCRIPTION	DATE	CHKR-APVD
—	#	SEE SHEET 1		

ENCODER TYPE	DIM.A	ENCODER TYPE	DIM.A	ENCODER TYPE	DIM.A
*RI 13/35QP	3.00	*RI 20K/35QP	3.00	RI 64K/35QP	3.00
*RI 13/35QPZ	3.00	*RI 20K/35QPZ	↑	RI 64K/35QPZ	4.00
*RI 13/35Q	3.00	*RI 20K/35Q	│	RI 64K/35Q	3.00
*RI 13/35QZ	3.00	*RI 20K/35QZ	│	RI 64K/35QZ	4.00
*RI 14/35QP	3.00	*RI 32K/35QP	│	RI 72K/35QP	3.00
*RI 14/35QPZ	3.00	*RI 32K/35QPZ	│	RI 72K/35QPZ	4.00
*RI 14/35Q	3.00	*RI 32K/35Q	│	RI 72K/35Q	3.00
*RI 14/35QZ	3.00	*RI 32K/35QZ	│	RI 72K/35QZ	4.00
*RI 15/35QP	3.00	*RI 36K/35QP	│	RI 80K/35QP	3.00
*RI 15/35QPZ	3.00	*RI 36K/35QPZ	│	RI 80K/35QPZ	4.00
*RI 15/35Q	3.00	*RI 36K/35Q	│	RI 80K/35Q	3.00
*RI 15/35QZ	3.00	*RI 36K/35QZ	│	RI 80K/35QZ	4.00
RI 16/35QP	3.00	*RI 40K/35QP	│	RI 100K/35QP	3.00
RI 16/35QPZ	4.00	*RI 40K/35QPZ	│	RI 100K/35QPZ	4.00
RI 16/35Q	3.00	*RI 40K/35Q	│	RI 100K/35Q	3.00
RI 16/35QZ	4.00	*RI 40K/35QZ	│	RI 100K/35QZ	4.00
RI 17/35QP	4.00	*RI 50K/35QP	│	RI128K/35 THRU RI200K/35 ALL OPTIONS	4.00
RI 17/35QPZ	4.00	*RI 50K/35QPZ	│		
RI 17/35Q	4.00	*RI 50K/35Q	↓		
RI 17/35QZ	4.00	*RI 50K/35QZ	3.00		

1. ELECTRICAL CONNECTIONS:

	PIN NO.	FUNCTION			
		QP OPTION	QPZ OPTION	Q OPTION	QZ OPTION
	1	CCW OUTPUT	CCW OUTPUT	N.C.	N.C.
	2	CW OUTPUT	CW OUTPUT	N.C.	N.C.
	3	N.C.	INDEX PULSE P	N.C.	INDEX GATE
	4	COMMON	COMMON	COMMON	COMMON
	5 (SEE NOTE 1)	-6 VDC	-6 VDC	-6 VDC	-6 VDC
	6 (SEE NOTE 2)	+6 VDC	+6 VDC	+6 VDC	+6 VDC
	7	CASE GND	CASE GND	CASE GND	CASE GND
	8	OUTPUT A	OUTPUT A	OUTPUT A	OUTPUT A
	9	OUTPUT B	OUTPUT B	OUTPUT B	OUTPUT B
	10	+VDC SENSE	+VDC SENSE	+VDC SENSE	+VDC SENSE
	11	SENSE RETURN	SENSE RETURN	SENSE RETURN	SENSE RETURN
	12	N.C.	INDEX GATE	N.C.	N.C.
	13	N.C.	N.C.	N.C.	N.C.
	14	N.C.	N.C.	N.C.	N.C.
	15	N.C.	N.C.	N.C.	N.C.
WITH LINE DRIVERS	1.	CW OUTPUT	CW OUTPUT	AQ	AQ
	2.	$\overline{\text{CW}}$ OUTPUT	$\overline{\text{CW}}$ OUTPUT	$\overline{\text{AQ}}$	$\overline{\text{AQ}}$
	3.	N.C.	INDEX GATE	N.C.	INDEX GATE
	4.	COMMON	COMMON	COMMON	COMMON
	5. SEE NOTE 1	-6VDC	-6VDC	-6VDC	-6VDC
	6. SEE NOTE 2	+6VDC	+6VDC	+6VDC	+6VDC
	7.	CASE GRD	CASE GRD	CASE GRD	CASE GRD
	8.	OUTPUT A	OUTPUT A	N/C	OUTPUT A
	9.	OUTPUT B	OUTPUT B	N/C	OUTPUT B
	10.	+VDC SENSE	+VDC SENSE	+VDC SENSE	+VDC SENSE
	11.	SENSE RETURN	SENSE RETURN	SENSE RETURN	SENSE RETURN
	12.	N.C.	INDEX PULSE P	N.C.	~~INDEX GATE~~
	13.	N.C.	$\overline{\text{INDEX PULSE P}}$	N.C.	N/C
	14.	CCW OUTPUT	CCW OUTPUT	BQ	BQ
	15.	$\overline{\text{CCW}}$ OUTPUT	$\overline{\text{CCW}}$ OUTPUT	$\overline{\text{BQ}}$	$\overline{\text{BQ}}$

GI QTY	ITEM NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	CODE IDENT

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED

ALL DIMENSIONS ARE IN INCHES. DIM AND TOL PER USA STD Y14.5. DIM APPLY AFTER PROCESSING.

TOLERANCES — 2 PLACE DEC ± .010 FRAC ± 1/64; 3 PLACE DEC ± .005 DEG ± 30 MIN

SURFACE ROUGHNESS PER USA STD B46.1 ✓

BREAK SHARP EDGES AND CORNERS .005 TO .020 RADIUS

MATERIAL N/A

FINISH N/A

NEXT ASSY

APPLICATION

		DATE
DWN	Paul Tebaldi	9-4-73
CHKR	RP	9/4/73
ENGR		
QA		
APVD		

Itek WAYNE-GEORGE DIVISION, NEWTON, MASSACHUSETTS U.S.A.

ENCODER RI__/35C OUTLINE

SIZE	CODE IDENT NO.		REV.
C	06130	2000-631	D
SCALE 1/1	WT	SHEET 2 OF 2	

C | 2000-631

FORM NO 39-7

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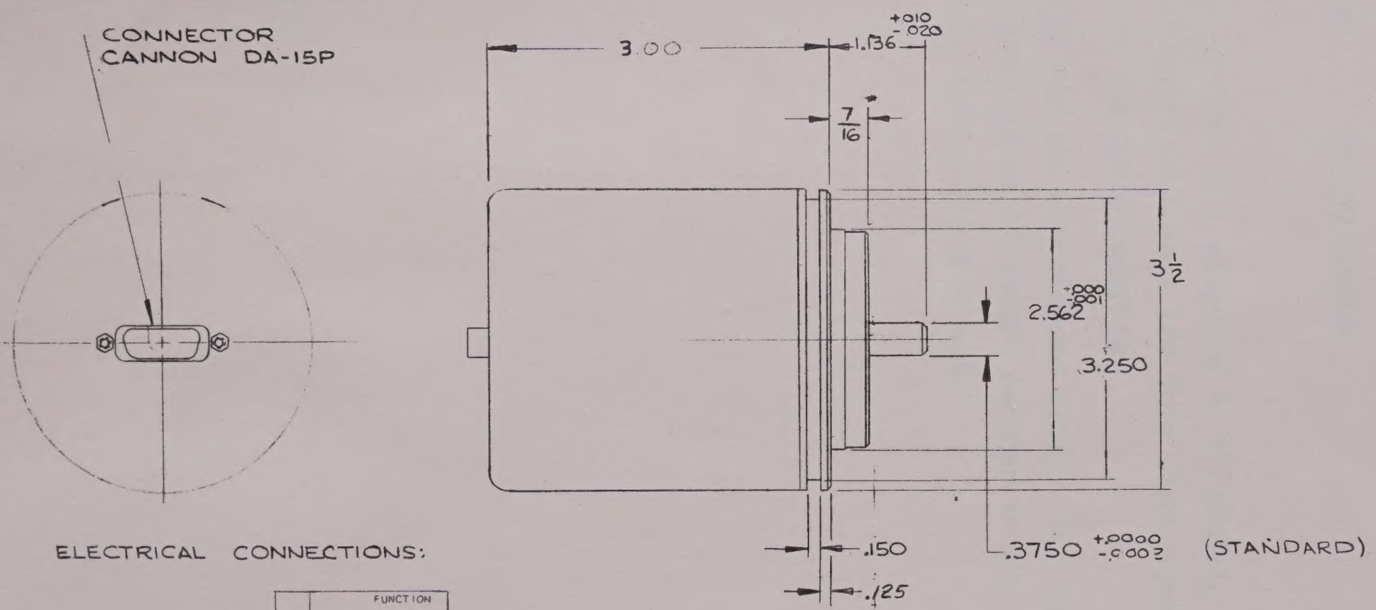
REVISIONS				
TR	ECO	DESCRIPTION	DATE	CHKR-APVD
-	-	REL. FOR PROD.	9/17/80	



ELECTRICAL CONNECTIONS:

PIN NO	FUNCTION QPZ
1	CCW OUTPUT
2	CW OUTPUT
3	INDEX PULSE P
4	COMMON
5	N.C.
6	+6 VDC
7	CASE GND
8	OUTPUT A
9	OUTPUT B
10	+VDC SENSE
11	SENSE RETURN
12	INDEX GATE
13	N.C.
14	N.C.
15	N.C.

QTY	ITEM NO	PART NO	DESCRIPTION	MATERIAL	SPECIFICATION	CODE IDENT

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED

ALL DIMENSIONS ARE IN INCHES. DIM. AND TOL. PER USA STD Y14.5. DIM. APPLY AFTER PROCESSING

TOLERANCES
2 PLACE DEC ± .010 FRAC ± 1/64
3 PLACE DEC ± .005 DEG ± 30 MIN.

SURFACE ROUGHNESS PER USA STD B46.1 ✓

BREAK SHARP EDGES AND CORNERS .005 TO .020 RADIUS

MATERIAL N/A

FINISH N/A

NEXT ASSY | APPLICATION

		DATE
DWN	Jim Sell	7-29-80
CHKR	RP	9/4/80
ENGR	KCK	8/28/80
QA		9/1/80
APVD		8/28/80

Itek WAYNE-GEORGE DIVISION
NEWTON, MASSACHUSETTS U.S.A.

ENCODER RI 36K/35CQPZX OUTLINE

SIZE	CODE IDENT NO		REV.
C	06130	2887-166	-
SCALE 1/1	WT	SHEET 1 OF 1	

ADDENDUM SHEET MANUAL #2781

S.O. #8437

COMMUNICATIONS SATELLITE CORP.

Part No.: 2887-232

Type: RI 17/35CQPZX

This encoder is a standard RI 17/35CQPZ, Part No. 2885-18, modified to include a 1/4 inch shaft diameter and Apiezon C vacuum lubricated bearing.

Except for the differences above, all other information on the standard RI 17/35CQPZ encoder in the main body of the manual applies to this model.

8/28/81